

Appl. No.: 10/716,232
Amdt. dated: March 1, 2006
Reply to Office Action of: November 1, 2005

Remarks/Arguments

Reconsideration and allowance of the above-referenced application are respectfully requested.

In the specification, three new paragraphs have been added at page 4, after line 4, that correspond to the language of the independent claims. Basis for the first new paragraph can be found in original claims 1-5 and 15 and in various parts of the specification. Basis for the second new paragraph can be found in original claims 30-31 and in various parts of the specification. Basis for the third new paragraph can be found in various parts of the specification and claims, including in original claims 1 and 15 and on page 8 of the specification. The paragraph beginning at page 7, line 20, has been amended to remove an inconsistency.

Claims 1-3, 6-9, 11-14, 16, 19-21, 24-35 and 37-48 remain in this application. Claims 4, 5, 10, 15, 17, 18, 22, 23 and 36 have been canceled, and new claims 42-48 have been added. Basis for new claims 42-43 can be found in various parts of the specification, including at page 8, line 14. The text of claims 44 and 48 is similar to the text of original claim 29. New Independent claim 45 is a combination of amended claim 1 and the subject matter of page 8, lines 9-18 of the specification. The language of claim 46 is similar to that of claim 2. The language of claim 47 is similar to that of claim 3.

Basis for the amendments to independent claims 1 and 30 can be found in original claim 15 and in various parts of the specification, including page 9, lines 20-21. Claims 2, 3, 6, 8, 12, 14, 16, 19-21, 24, 26, 32-34, 37, and 39 have been amended to be consistent with the claims from which they directly or indirectly depend. Claims 11, 25, 31 and 38 have been amended to cover certain embodiments of the invention.

The Office Action indicates that the Oath or Declaration is defective. A copy of the signed Declaration, along with a copy of the postcard receipt showing that this Declaration was received by the U.S. Patent and Trademark Office are attached hereto. It is noted that the executed Declaration was filed with a Missing Part Notice on April 12, 2004.

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Claims 1-41 are rejected under 35 USC Section 103(a) as being unpatentable over the Hydrocarbon Processing reference in view of Ihm et al, U.S. Patent No. 4,839,329. Reconsideration is requested.

The embodiments that are claimed in this amended application are directed to a method of producing propylene from a hydrocarbon feed stream by cracking the hydrocarbon and processing the resulting chemical grade ethylene to form propylene. Independent claims 1 and 30 of this application, as amended, and new independent claim 45, recite particular ways of integrating an ethylene plant recovery process and a metathesis process. In some cases, there is, at a minimum, a partial integration in which at least part of the ethylene and ethane from the deethanizer associated with the metathesis reactor and/or a dimerization reactor is recycled to the C₂ fractionator. (Figures 3 and 5 illustrate exemplary partial integration schemes in which recycle from the metathesis deethanizer is returned to the C₂ fractionator.) In other cases, there is a full integration in which there is no condenser associated with the deethanizer and the entire top stream from the deethanizer is sent to the C₂ fractionator. (Figures 4 and 6 illustrate exemplary full integration schemes in which all of the top stream from the metathesis deethanizer is returned to the C₂ fractionator and a portion of the C₂ stream 60 is diverted as stream 112 to be the reflux stream for the deethanizer 75.) As mentioned above, in both types of integration processes, chemical grade ethylene is used in metathesis. As a result of the specific partial and total integration processes that are claimed, ethane will not build up in the metathesis loop as it would if the metathesis and/or dimerization reactions merely followed the C₂ fractionation process. By returning the deethanizer overhead to the ethylene fractionator in the ethylene plant, ethane is purged out in the bottom of the ethylene fractionator and is returned to the cracking heaters as recycle to produce more ethylene.

Independent claim 45 and dependent claim 35 further provide that polymer grade ethylene is removed from the C₂ fractionator. Typically this polymer grade ethylene is an additional product stream of the inventive process.

The Office Action asserts that the Hydrocarbon Processing reference discloses a process for producing ethylene by steam cracking a hydrocarbon feed stock (page 96)

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and that another page of this publication discloses the dimerization of ethylene to produce butene, which is later reacted with ethylene to produce propylene (page 126). Furthermore, the Office Action contends that although the Hydrocarbon Processing reference does not disclose that acetylene is hydrogenated to ethylene¹ as is recited in step (b) of claims 1 and 30, Ihm '329 discloses this feature of the claimed embodiments. The Office Action asserts that it would have been obvious to modify the process disclosed on page 96 of the Hydrocarbon Processing reference by hydrogenating acetylene to ethylene and by dimerizing ethylene to produce butene, followed by reaction with ethylene to obtain propylene.

The Hydrocarbon Processing reference is a large collection of technology summaries, and contains technologies of 42 different companies. It is the applicant's position that pages 96 and 126 of Hydrocarbon Processing therefore should be considered two separate references. Thus, it appears that the Office Action effectively combines three different disclosures in order to reject independent claims 1 and 30.

In conventional metathesis, if the ethylene stream to a metathesis reactor contains 1% ethane, then the overhead will contain roughly twice as much since conversions are on the order of 40-50% (on a once-through basis). When this stream is recycled to achieve high ethylene conversions, the concentrations of ethane in the tower overhead will build up from greater than 2% once through to well over 10%. In order to prevent further build up, a vent typically is used. This stream purges ethane but also removes ethylene, representing a loss to the process. The embodiments claimed herein do not include such a vent and instead integrate the recovery of ethane and ethylene in a manner that saves equipment and energy. In the claimed embodiments, the top stream from the deethanizer is returned to the C2 fractionator.

Furthermore, certain embodiments including the embodiment shown in Figure 3 allow the ethylene/ethane mixture from the dimerization reaction to flow with the butenes overhead from the butene separation unit 88 to the metathesis reaction directly (claim 13). The contained C₂ stream will be small since ethylene conversion is normally

¹ The Examiner's attention is directed to the fourth paragraph of page 96 which states "Acetylene in the deethanizer overhead is hydrogenated (10) or recovered."

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greater than 80%, and more typically is 90% or higher. Rather than having a separate tower to recover this ethylene and purge the ethane, this mixture is allowed to pass to metathesis where it dilutes the feed chemical grade ethylene stream 66 slightly.

Independent claim 1 has been amended to include, in new step (g), "recycling at least a portion of said ethylene and ethane from said propylene-rich stream to said C2 fractionator." Independent claim 30 has been amended to include, in step (f), "recycling at least a portion of said removed ethylene and ethane to said C2 fractionator." New independent claim 45 contains similar language. Furthermore, all of the independent claims provide that the ethylene fraction from the C2 fractionator that is used in metathesis is chemical grade ethylene having an ethylene content of less than 99%. These features are not disclosed or suggested by the cited references.

Dependent claims 12, 19 and 33 provide that a portion of the ethylene fraction from the C2 fractionator is fed to the metathesis section as reflux. This further integration process, which is illustrated in the embodiment of Fig. 4, allows for the elimination of a condenser for the deethanizer, as indicated above.

Dependent claim 14 contains a further integration concept, which is exemplified by stream 86 in Figs. 3 and 4. Purge 87 (included in Fig. 2) is not present in Figs. 3-4. C4s and heavier hydrocarbons are removed from the depropanizer 82 in stream 86 and sent to butene separation 88, thereby resulting in a higher recovery of butenes.

As mentioned above, dependent claim 35 and independent claim 45 recite the production of a polymer grade ethylene product in addition to the chemical grade ethylene, which even further distinguish them from the cited references.

Thus, the invention as claimed is not obvious in view of the cited references.

In view of the above, it is believed that this application is in condition for allowance, and such a Notice is respectfully requested.

A telephone interview is respectfully requested at the number listed below prior to any further Office Action, i.e., if the Examiner has any remaining questions or issues

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to address after this paper. The undersigned will be happy to discuss any further Examiner-proposed amendments as may be appropriate.

Respectfully submitted,

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